THE HAPN-T 4800 BAUD MODEM DESIGNED FOR THE TAPR (AND CLONES) TNC's

HAPN (Hamilton and Area Packet Network) is a packet radio club founded in 1980 and dedicated to furthering the state of packet radio. We developed the user-friendly HAPN-1 TNC (plug in TNC for IBM-PCs). This project was a great success, and numerous HAPN-1 adapters are now in use in countries all over the world. Money raised with these projects helps us pay for research and development.

We also designed the HAPN 4800 baud modem. This modem, which can be used with regular 2 meter or VHF radios, uses the same bandwidth as conventional 1200 baud modems and generally performs better. Throughput increases up to 4 times. HAPN has been running 4800 baud on our local area network for more than 2 years.

There are now several versions of the modem. One version can be added to the prototype area on the HAPN-1 adapter. Another is the HAPN-M which is a 4800 baud modem with an RS232 interface for the VADCG TNC. Our latest version is the "HAPN-T", a 4800 baud modem for TAPR type TNCs.

HAPN
BOX 4466, STATION D,
HAMILTON, ONTARIO
CANADA, L8V4S7

section 1. HAPN-T CIRCUIT BOARD ASSEMBLY

( ) Use the parts list (see section 11) and check over all the parts.
( ) Visually check circuit board under a bright light.
( ) NOTE: bend leads for resistors and diodes to .4 inches (10.4mm) lead space.
!! Make note of R27. The silkscreen shows 4.7K, it should be 1K !!
!! Make note of C30. This cap should not be installed. !!
( ) Mount resistors, following silkscreen and component mounting diagram. Solder and trim leads.
( ) Mount the diodes, watching the polarity. The band is the cathode. Solder and trim leads.
( ) Mount sockets, watching the direction. The notch side is near pin 1.
( ) Mount the tantalum capacitors. Be careful bending leads, and watch the polarity!
( ) Mount remainder of capacitors exept C30. Trim leads.
( ) Mount the trimpots. NOTE: The pots are a little too close to the components behind them.
Raise them a little to clear R36, C21, R8 and R7 when soldering.
( ) Mount female connector J4 on the bottom side of the modem board.
( ) Cut at length and mount posts J100 (2pin), J101 (3pin), J104 (2pin) and J105 (2pin).
( ) With an analog ohmmeter check: pin J4/15 (gnd) and +12V lead for about 16K.
( ) If you are installing the modem to a TNC-1, go to section 7; else continue with section 2.

section 2. PREPARE THE TAPR TNC-2 (TNC-2 only)

The modification consists of installing the external modem connector J4 (if not already present) and adding one wire to feed 4800 baud clock pulses to vacant pin 16 of connector J4.

Instructions are given for an MFJ TNC-2; others may vary:
( ) remove covers from TNC (on MFJs also remove the front plate).
( ) remove 4 screws and remove the mother board.
( ) on back of the board cut the trace between J4 pin 11 and 12 (clock pulses).
( ) on back of the board cut the trace between J4 pin 17 and 18 (receive data).
( ) solder in the male connector J4.
( ) solder a small gauge wire from U1 pin 7 to J4 pin 16 (4800 baud clock).
( ) optionally, a miniature switch can be added for easy switching between 1200 and 4800 baud. A good place for mounting this switch is the left screw hole of the front panel.
( ) Make sure that J10 on the TAPR TNC is not so high as to interfere with the bottom of the modem board. If it is too high, trim height of J10 with a pair of side cutters.
( ) reinstall the board in the cabinet.

Testing :
( ) Before proceeding with the installation of the modem board, test the TNC by temporarily installing jumpers at J4 pin 11-12 and J4 pin 17-18. This restores the original traces and let you verify the TNC is still functional before continuing with the installation of the modem board.
( ) Continue with section 3.

section 3. INSTALL MODEM BOARD IN THE TAPR TNC-2 (TNC-2 only)

( ) +12V hookup: Solder a wire from the 12V pad on the modem board (near corner cut) and connect to a 12V source on the TNC (such as the cathode of CR7 on the TNC-2).
( ) Plug the modem board into the TNC male header, and make sure that the board is properly plugged in by looking at it from the side.
( ) With an ohmmeter, check for 0 ohms between square pad J102 pin 2 on the modem board and ground on TAPR TNC

(such as RS232 pin 7). This step verifies proper mating of the J4 connector (VERY important).
( ) The following step requires 4-conductor shielded audio cable and a male DIN plug(s). Use Radio Shack cable part #42-2151, cut in half.
( ) Refer to the circuit diagram and hook up the TNC interface wires to J102 using the above cable and DIN plug. The shield goes to J102 pin 2. The 5 pin DIN plug is to be plugged into J2 of the TNC.
( ) Refer to the diagram and hook up J103 to the radio site using the shielded cable again. The shield goes to J103 pin 2.
( ) Test the 1200 baud operation using your old radio interface points, such as speaker at J103-4 and audio at J103-1.
( ) Refer to section 6 (MODIFYING THE RADIO) and change RX-audio J103-4 to the discriminator tap point.
( ) Refer to same section and add the 4800-TX-audio J103-5 line to the modulator tap point.
( ) Continue with section 4.

== section 4. ADJUSTING THE HAPN-1 MODEM ==

( ) Install the modulation selection jumper on J101 posts (refer to radio manual for modulater type):
FM modulators (most radios) side closest to R37 pot (pins 1 & 2).
PM modulators position jumper away from R37 pot (pins 2 & 3).
( ) Adjust the modem potentiometers. Make sure the radio is connected and turned on.
1. Level adjustment R2: Put an old-fashioned analog meter at TP1 and adjust for about 9 VDC when receiving noise (no antenna) (If you have a scope use U3A/1 (TP4) and adjust until the noise signal is just short of clipping.)
If you find that turning R2 does not decrease the signal sufficiently install jumper J104 to decrease the op-amp gain.
2. Squelch (carrier detect) adjustment R23: Turn until the DCD light on the modem is on when the radio is turned off, and ~~goes on~~ when the radio is turned on and receiving noise (coarse adjustment). Hook up the antenna and connect a voltmeter to TP3. Monitor an active packet channel (1200 or 4800). Turn the pot until you measure about 2.5V or higher with carrier and .5V or lower with no carrier.
3. Transmit level adjustment R37: Make sure jumper J101 is installed as mentioned earlier. Put modem in 1200 baud mode by opening switch on TNC-2 (J105 removed) or on TNC-1 select BANK 0 and and hit reset. Hook up an AC voltmeter or scope to J103 pin 5. Now key-up long 1200 baud packets (or use the CALIBRA command) while observing the meter. Write this value down here(1): _____ (this is your 1200 baud operating level). Now temporarily increase it to maximum reading by turning the 1200 level pot on the TNC board. If you are like most packeteers, feeding audio in through the mike might not further increase due to the signal hitting the limiters in the radio. Write this value down here(2): _____ (this is your limiting value, usually about 5KHz deviation). Now take 70% of this value and write down here(3): _____ (this is your preferred transmit level, about 3-3.5KHz deviation). Turn the level pot on the TAPR TNC back to the value recorded at "here(1)" above. Now switch to 4800 baud by installing the jumper at J105 (TNC-1 select BANK 1 and hit reset). Key-up the TNC again. This time packets are at 4800 baud and observe the level. Adjust R37 till you read the value at "here(3)".
( ) continue with section 5.

== section 5. SOME ADDITIONAL NOTES ==

Adjustments are now complete and you are ready to try on-the-air tests. If you encounter poor results, make sure your radio is on frequency, both for transmit and receive. Finally, when all is well, cut down on your TXdelay and possibly other delays. The TXdelay can be made shorter due to the fast acting modem squelch, which switches in about 10 Msec. This will result in better utilization of the available radio channel. If at this point you have everything working, and you wish to experiment some more, you can try the 4800 tap points on 1200 baud also. This often results in better performance for 1200 baud reception and eliminates the additional interface wire(s). It also has the benefit that you don't have to watch your radio's volume and squelch control any more since they will be bypassed. For more information on these subjects, check section 10 (SERVICE AIDS). An additional modification you can try out to improve 1200 reception (has nothing really to do with the 4800 baud modem) is bypassing the MF10 filter in the TNC. Some of the newer TNCs, such as the MFJ1270B and MFJ1274, have recognized this and have eliminated this filter altogether.

Notes:
If you still encounter problems at this point, check all previous steps, then check the SERVICE AIDS in section 10.

For a description of the workings of the modem refer to the HAPN article in the August 1988 issue of HAM RADIO "A 4800 baud modem for VHF/UHF packet radio", which described a similar modem for the HAPN-1 TNC.

In case you discover errors in the instructions or have suggestions for further improvements, send us a note at the above HAPN address or via packet mail to John, VE3DVV @ VE3KOI. Don't forget, we are interested in your feedback.

End of guided instructions.

== section 6. MODIFYING THE RADIO ==

The mike and speaker hookup points are not suitable for 4800 baud use and new interface points have to be selected.

For the 4800 Rx-audio, use the output of the discriminator just before the de-emphasis network. Many radios use the MC3357P or the MC3359 FM chips. The output impedance of these chips are around 300-400 ohm which makes it easy to interface. As a safety precaution a 1k series resistor could be used to limit the current if you accidently short this line to ground. On the MC3357 connect to pin 9 of this chip (example IC27A). My Santec ST-144up uses test point CT5 which is close to this pin, but easier accesable. The audio tap point for a MC3359 is pin 10 (example AZDEN PCS-5000).

An older rig like the IC22S would use the discriminator test point on the rear connector (pin 1) for receive. To avoid the receive noise component (11 khz needed for the squelch) from being attenuated, remove bypass C38 and replace C3 with a 1000 Pf capacitor. As a rule try to keep the capacitance to a minimum on the 4800 RX AUDIO line, especialy when the output impedance is high (larger then 10k).

For the 4800 TX-audio, tap at the point where the audio goes into the modulator (after the limiter filter). The FM modulation is always done at the oscillator. PM is done at a stage following the oscillator. Position jumper J101 accordingly. For an IC27A (FM) hook up to point that says MOD. My SANTEC ST-144 handheld is fed in at test point CT1. On the IC22S just run a wire from the rear connector to junction of R118, R117 and C125. Often a small series resistor (100 to 1000 ohm) is used to gives some isolation for a low impedance point. For an high impedance point use a 10k to 100k resistor. This often allowes

you to leave the TNC to be connected to the radio when using the MIKE. Preferable however is to unplug the mike when using the radio for packet.

The PTT line for keying up the radio usually is connected to the PTT line that goes to the mike.

( ) Return to calling section.

== section 7. PREPARE THE MODEM BOARD FOR THE TNC-1 (TNC-1 only) ==

NOTES:
The boxed-in area left of J102 on the modem diagram shows the interface pins for the TAPR TNC-2, which is a 5 pin DIN connector. This does not apply for the TNC-1. The TNC-1 uses J3 for the radio port, which is a DB9 connector. For pin numbers for the radio port J3, refer to the TNC-1 manual.

Since the modem requires a unique 4800 Rx-Audio and 4800 Tx-Audio tap point in the tranceiver, these signals are brought in via spare pins 1 and 2 of J3.

Switching between 1200/4800 BPS could be done by adding/removing the baud rate select jumper (SW) on the modem board. However, this is not very handy when the TNC cabinet is closed. A convenient alternative is where the the BANK select switch also functions as the modem select switch. The spare LED lights up in the 4800 BPS mode (BANK 1) position and is off in the 1200 (BANK 0) Bps position. Some additional wires to the back of the TNC board are added to accomplish this. The change makes use of a spare inverter gate on the TNC board. This wiring does not interfere with normal operation and could be left in place if you ever choose to remove the modem.

( ) Rework the modem board so it can be used with the TNC-1 :
- solder a small diode (1N914) on the modem board from J102 pin 5 (kathode) to J4 pins 1 and 2 (anode) (this allowes the 4800 carrier detect to be combined with the 1200 data carrier detect)
- connect pins 7 and 8 of J4 together on top of the modem board
- connect pins 11 and 12 of J4 together on top of the modem board
- float pin 16 of J4 by bending out pin 4 of MC14551 (U1)

( ) Optional change (recommended):
Rework the modem board so it will support a TTL level for baudrate switching:
- mount a 47K resistor on the modem board below R31, using the holes provided.
- solder a NPN silicon transistor (such as 2N3904) on the modem board using the holes and traces provided. The collector goes to J105, the emitter to ground and the base to the 47K resistor.

( ) Continue with section 8.

== section 8. PREPARE THE TAPR TNC-1 (TNC-1 only) ==

( ) Remove TNC-1 mother board from cabinet.
( ) Remove jumpers on the J5 modem connector.
( ) The original TNC-1 uses for J5 (modem interface) a fancy connector with hinges that interfere with the plugging in of the modem board. Remove these hinges by popping them out. Use a hacksaw blade and cut off the four extending tips of the connector so the top is flush with the pins.
( ) Rework the back panel of TNC-1 box as follows:
- to avoid interference with the modem board, remount the power transformer 1cm (.3 inch) higher. Also bend lugs 1 and 2 back away from the modem board.

( ) Solder a short wire about 2.5 cm (1 inch) between the LED pad at U21 pin 13 and R7 (side that goes to U27 pin 17). This allows the LED to come on in the BANK 1 position (4800 BPS).
( ) From above pad at U27 pin 13, connect a wire to unused inverter input U25 pin 9. (This inverter will be used to silence the XR2206 in 4800 Bps mode.)
( ) Connect output of the inverter U25 pin 8 to U19 pin 10.
( ) Mark the spare LED on the front panel now "4800" baud.
( ) Install TNC board back in the cabinet.

Testing :
( ) Before proceeding with the installation of the modem board we test the TNC by temporarily installing jumpers at J5 at : pins 1-2, 5-6, 7-8, 9-10, 11-12, 13-14, 17-18 and 19-20. The TNC should work like before on 1200 baud and in addition the BANK switch should make the 4800 LED light up in the BANK 1 position.
( ) Continue with section 9.

== section 9. INSTALL MODEM BOARD IN THE TAPR TNC-1 (TNC-1 only) ==

( ) Use 25 cm (about 1 foot) of 2 conductor shielded wire such as Radio Shack No. 278.1275 and connect 4800 signal wires from bottom of TNC board :
shield J3 pins 6,7,8,9 to J102-2 (GND)
wire J3 pin 1 to J102-4 (4800 Rx AUDIO)
wire J3 pin 2 to J102-5 (4800 Tx AUDIO)

( ) +12V hookup : Solder a wire from the 12V pad on the modem board (near corner cut) and connect to +12V side of R49.
( ) Solder a small gauge wire from the right side of the 47K base resistor on the modem board to the junction of R27/R21 on the TNC board (TTL baud switch).
( ) Plug in the modem board and make sure to orientate it properly. The board covers U13 and U17 when plugged in correctly.
( ) !!!! WARNING !!!! :
Check for proper mating of the modem board. Use ohmmeter and check for continuity between U18 pin 5 on the TNC1 and J102 terminal 5 on the modem board.
( ) Put RAM/ROM switch in RAM position and select BANK 0.
( ) Turn on power and program the parameters for 1200 and 4800 BPS :
BANK 0 for 1200 baud parameters (HBAUD 1200)
BANK 1 for 4800 baud parameters (HBAUD 4800)
Do PERM command to save them.
( ) NOTE : To switch modes all you have to do is select the proper bank and hit reset.

( ) Check point :
    - The 4800 LED should be "ON" in BANK 1 position and "OFF" in BANK 0,
    - With radio disconnected or turned off, the DCD LED should be "ON" (no noise being received).
( ) Continue with section 4.

section 10. SERVICE AIDS

MODEM SERVICE AIDS

( ) Check for poor or missing solder joints.
( ) Verify IC's plugged in properly, bent pins etc.
( ) Check op amps. With no signal (radio turned off and not transmitting) the outputs of the OP-AMPS U3b, U3a, U3c, U5a, U5b should be 6V (same level as U3d/14). Outputs of U5d and U5c should be 5V (same as zener D5 voltage).
( ) If not getting enough high freq noise from receiver for the squelch to operate properly (need about 2V swing at squelch gate U6a/1), some bypass capacitor on the line from the RX-audio tap point might be the culprit. Remove or replace with a smaller value. If this is not the case more (HF about 11khz) noise can be picked up by increasing C2 (try 1500PF).
( ) On one of the test boards the 6V line went into oscillation (abt. 200Khz). If this happens remove bypass C30 to stop it.

RADIO SERVICE AIDS

( ) Signals at TP1 and TP2 referenced to U3d/14 should be about equal with noise. If not, check if you're picking up a weak receive signal such as computer noise. In this case, turn computer off for this check, or change frequency, disconnect antenna and check again. If the reading still persists and it is severe, your Rx-discriminator might be out of whack.
( ) If 4800 packet signal levels at TP1 and TP2 vary a lot but the above noise test is ok, suspect your receiver (or the sender) to be off frequency.

SERVICE AIDS FOR TNC-2

( ) To eliminate the "1200 MIKE AUDIO" line and use the 4800 TX AUDIO for 1200 BPS also do the following :
Disconnect the wire at J103 pin 1 (1200-mike-audio) and install a jumper at J100. After this, you will have to re-adjust the 1200 baud audio level control (R76 on MFJ1270B) on the main board. If the level is too low, short out the series output resistor (R56) and/or increase the coupling capacitor value.
( ) To bypass the MF10 filter in the MFJ1270 (note: MFJ1270B or MFJ1274 does not use them) unplug U18 and replace network U17 with a DIP header. Connect pins 1 and 8 on the header. The result will be a flat audio response where the High and Low tones (2200 and 1200) should have more equal amplitude.
(The XR2206 chip has trouble decoding when they are too different.)
( ) If you like to use the 4800 carrier detect for 1200 Bps as well, ground XR2211 DCD line U20 pin 6 on TNC-2. Then connect U6 pin 2 to pin 14 (+5V) on the modem board. This enables the 4800 CD unconditionally. Next install jumper J105 and move one of the wires of the baudrate switch to GND. This should make U1 pin 9 about 10V at 4800 Bps or 0V at 1200 Bps.

SERVICE AIDS FOR TNC-1

( ) Recheck proper mating of the modem board.
( ) Check +5V and +12V supplies for ripple. If you see ripple, change the primary tap of the transformer. (example: change tap from 115V to 105V)
( ) In the TNC under test, the C1 filter capacitor had dried out and lost capacitance. Replacing it with a new 3300 mfd 16 V electrolytic solved the problem.
( ) Parameters to review:
    AXDELAY default 0 could be too fast for turnaround for some radios.
    TXDELAY default of 4 (160 msec) can likely be decreased for 4800
             (could be set to maximum if a scope pattern is required).
    HBAUD   set to 4800 (BANK 1) and 1200 (BANK 0).
( ) To bypass the MF10 filter in the TNC-1, unplug U28 and replace network U30 with a DIP header. Connect pins 1 and 8 on the header. The result will be a flat audio response where the High and Low tones (2200 and 1200) are more equal in amplitude. (The XR2206 chip has trouble decoding when the amplitudes of these tones are too much different).
( ) To use the 4800 tap points in the radio also for 1200 BPS we have to make the TXAUDIO switchable between the XR2206 modem and the 4800 BPS modem (U5b/7). We accomplish this by adding a small cable that plugs into the TNC RADIO PORT J3 and runs to the J102 connections on the modem board. The modem multiplexer (U1) will then switch the TXAUDIO line. The output of the multiplexer (J103) will go to a new 5 pin DIN connector which is our new radio port connector. In addition, the TNC RCVR impedance needs to be made less capacitive so as not to load down the 1200/4800 RX AUDIO line. Do the following :
    - Add a new connector for interfacing to the radio. Make a hole and mount a 5 pin DIN chassis connector (Radio Shack p/n 274-005) beside the transformer and above the cutout for radio conecter J3.
    - Use 4-conductor shielded wire and install a male DB9 connector on one end. Hook up the wires as follows:
      wire from J102-1 to DB9P-5 (MIC)
      shield from J102-2 to DB9P-8 (GND)
      wire from J102-3 to DB9P-4 (PTT)
      wire from J102-4 to DB9P-3 (RCRV)
    - Use 4-conductor shielded wire again and hook up the new radio connector :
      wire from J103-1 to DIN-1 (1200 MIKE AUDIO) NOTE: available, but not used in this configuration
      wire from J103-2 to DIN-2 (GND)
      wire from J103-3 to DIN-3 (PTT)
      wire from J103-4 to DIN-4 (1200/4800 Rx AUDIO)
      wire from J103-5 to DIN-5 (4800 Tx AUDIO) NOTE: used for 1200 Bps as well
    - Hook up the radio via DIN connector using GND(2), PTT(3), 1200/4800 Rx AUDIO(4) and Tx AUDIO(5)
    - Lower the input capacitance of the TNC-1 by removing C64 (.01mfd) on the TNC board (optionally replace with .001mfd). If the optional R59 (560 ohm) resistor is present, remove it.
    - Short out R41 (30K) on motherboard to get more audio drive.
    - File a small notch in back panel beside the RADIO connector to allow the above cable to pass through.
    - Plug in the male DB9P into the RADIO port J3.
    - Install jumper J100 on modem board.
    - Check that J103 pin 1 (1200 MIKE AUDIO) is not connected any more (bend out pin U1/13 if necessary).
    - Adjust transmit level with R33 for same level as 4800 TX AUDIO (3-3.5Khz deviation).
( ) If you like to use the 4800 carrier detect for 1200 Bps as well, float XR2211 DCD line U18 pin 5 on TNC-1 and connect U6 pin 2 to pin 14 (+5V) on the modem board. This enables the 4800 CD unconditionally.

section 11. PARTS LIST FOR HAPN-T 4800 BAUD MODEM REV.1.0

Resistors 1/4 watt 5 %

2	22 Ohm	R32,33
1	100 Ohm	R46
2	560 Ohm	R20,47
2	1k	R27,34
4	4.7K	R17,18,19,22
1	6.8K	R36
4	10K	R3A,4,31,35
2	15K	R12,45
1	22K	R50
3	39K	R8,30,40
10	47K	R7,13,16,38,39,41,42,43,48,49
4	56K	R5,6,9,10
9	100K	R1,3,11,14,15,24,28,29,44
1	270K	R26
1	330K	R21
1	1M	R25
1	5K	R37 potentiometer
1	10K	R2 potentiometer
1	50K	R23 potentiometer

Capacitors

13	1 nf	C2,4,5,6,7,11,12,15,22,23,24,25,26	
1	4.7 nf	C10	(472 marking)
1	47 nf	C14	(473 marking)
1	10 nf	C21	(103 marking)
5	.1 mfd	C1,3,8,9,27	(104 marking)
1	.15 mfd	C13	(154 marking)
4	4.7mfd	C17,18,19,20	(tantalum)
3	10 mfd	C16,28,29	(tantalum)

Diodes

4	1N914	D1,2,4a,4b	(silicon)
1	1N34A	D3	(germanium)
1	1N5231B	D5	(zener)

Sockets

5	14 pin dips	U2,3,4,5,6
1	16 pin dip	U1

1 HAPN-T circuit board

IC's

1	MC14551	U1
1	LM339	U2
2	TL084	U3,5
1	74HC00	U4
1	74HC132	U6

Connectors

1	2x10 pin female	J4
2	10 pin male	J4
1	2 pin male	J100
1	3 pin male	J101
1	2 pin male	J104
1	2 pin male	J105

Jumpers

3 jumper J101,104,105

section 12. LIST OF ITEMS AVAILABLE FROM HAPN

HAPN-1	Assembled and tested packet adapter for the IBM-PC (and clones) with distribution DISK #1, containing the background operating AX.25 packet driver program, user friendly menu driven host software with ASCII/binary file tranfer, Q-answer mode, T25 test program and complete manual. A programmer's C interface library is also included on this disk for individuals interested in developing their own application programs. For a technical description refer to the original article "TNC for the IBM PC" in the August 1986 issue of HAM RADIO Magazine.	194$US	240$Cnd
HAPN-1	Bare board and bracket with above DISK #1 containing a total of 6 programs, manual with assembly instructions and diagram.	70$US	86$Cnd
HAPN-1	Bare board, bracket and the sometimes hard to find Intel 8273 chip. Includes DISK #1 with assembling instructions and diagram.	85$US	105$Cnd
DISK #1	Software only (6 programs, diagrams and instructions).	35$US	40$Cnd
DISK #2	Feature software containing the PCRBBS bulletin board and automated file transfer programs SF/RF, YAPP and X-packet.	20$US	25$Cnd
DISK #3	VADCG packet protocols V1 and V2	20$US	25$Cnd
HAPN-48	Instructions for adding the HAPN 4800 baud modem to the prototype area on the HAPN-1 TNC. Contains T48 test program and detailed construction diagrams with step by step instructions. (For more information refer to our article "A 4800 Baud Modem For VHF/UHF Packet Radio" in HAM RADIO August 1988).	5$US	6$Cnd
HAPN-M	4800 baud bare modem circuit board with instructions (contains RS232 modem interface for VADCG, ASHBY TNCs etc.)	20$US	25$Cnd
HAPN-T	4800 baud bare circuit board with diagram and instructions (plug-in 4800 baud modem daughter board for TAPR TNCs)	15$US	18$Cnd
HAPN-T	4800 baud modem kit. It includes circuit board and parts (plug-in 4800 baud modem daugther board for TAPR TNCs)	48$US	60$Cnd

Notice : Prices are in $US or $CAN funds. For shipping and handling add $5 in US or $8 for overseas orders. A 10% discount applies to orders of 5 or more of any item.

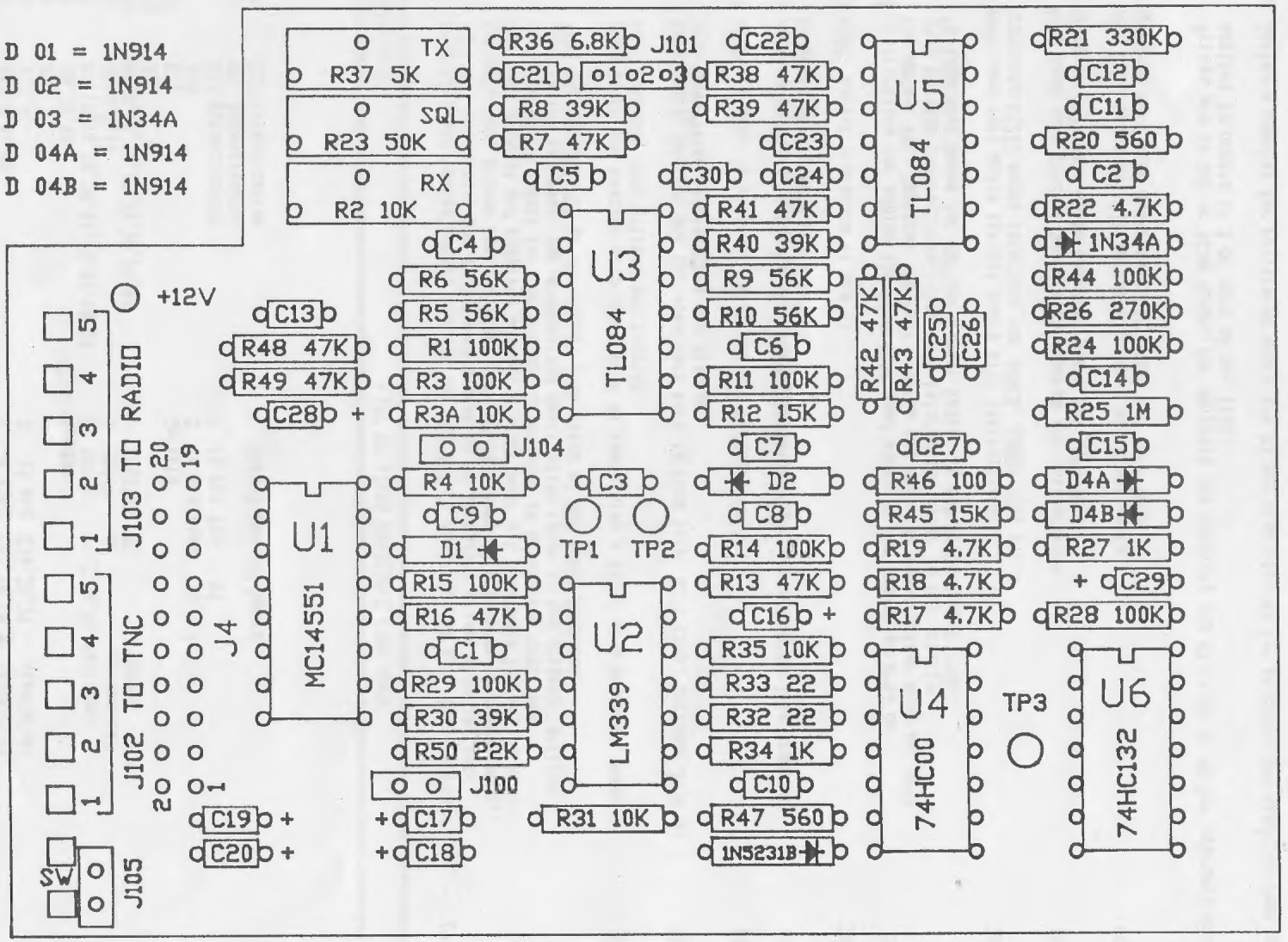
Updates: Software updates for registered users are $5 per disk plus $5 for shipping and handling (see our HAPN newsletters).

HAPN's address is :

HAPN
Box 4466, Station D,
Hamilton, Ontario,
Canada, L8V4S7

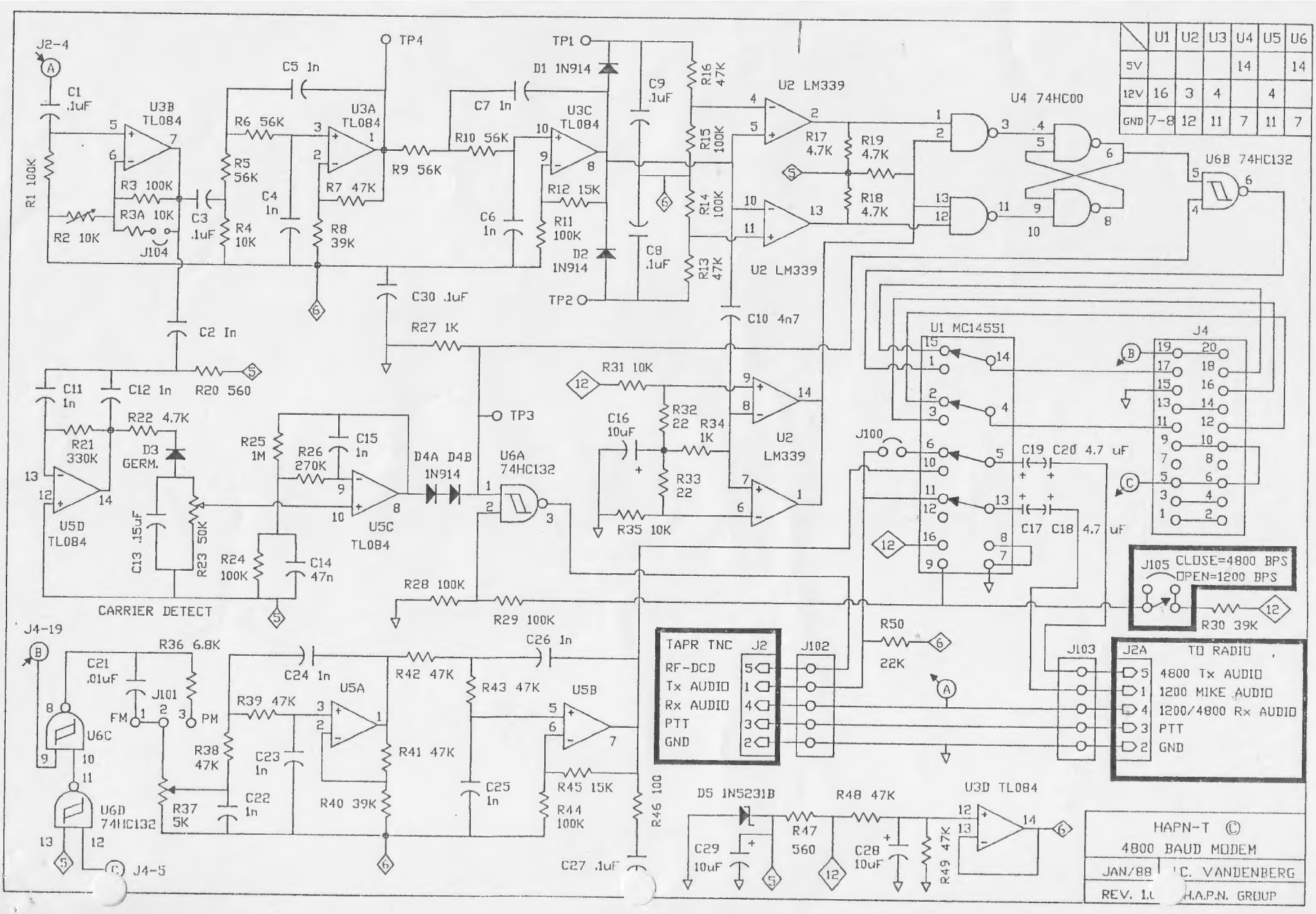
C 01 = .1 uF
C 02 = 1 nF
C 03 = .1 uF
C 04 = 1 nF
C 05 = 1 nF
C 06 = 1 nF
C 07 = 1 nF
C 08 = .1 uF
C 09 = .1 uF
C 10 = 4.7 nF
C 11 = 1 nF
C 12 = 1 nF
C 13 = .15 uF
C 14 = 47 nF
C 15 = 1 nF
C 16 = 10 uF
C 17 = 4.7 uF
C 18 = 4.7 uF
C 19 = 4.7 uF
C 20 = 4.7 uF
C 21 = .01 uF
C 22 = 1 nF
C 23 = 1 nF
C 24 = 1 nF
C 25 = 1 nF
C 26 = 1 nF
C 27 = .1 uF
C 28 = 10 uF
C 29 = 10 uF
C 30 = .1 uF

D 01 = 1N914
D 02 = 1N914
D 03 = 1N34A
D 04A = 1N914
D 04B = 1N914



PARTS POSITION

HAPN-T 4800 MODEM REV. 1.0



	U1	U2	U3	U4	U5	U6
5V				14		14
12V	16	3	4		4	
GND	7-8	12	11	7	11	7